The Tissint Meteorite as an Analogue for Mars Sample return.

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The fall and recovery of the Tissint meteorite in 2011 provided a unique opportunity to study a piece of Mars with minimal terrestrial exposure. Analysis of the organic content of this meteorite with a suite of techniques began in summer 2012. The basis of the analysis philosophy was to treat this analysis as a dry run for Mars sample return samples with a particular emphasis on organics analysis and life detection protocols. These are summarized in Steele et al., 2016 as depending on several key points for implementation (*1*): 1) An understanding of possible abiotic chemistry undertaken in Mars environments and the preservation / diagenesis of that signal with time. 2) A clear understanding of the geological context in which measurements are made. 3) A multidisciplinary and multi-measurement approach with convergent data sets from each measurement. 4) Commitment to null hypothesis testing. 5) Clear operating guidelines and peer review of results and data. The results of a combination of *in situ* and whole rock analysis has revealed an inventory of aliphatic and aromatic organic compounds indigenous to the meteorite including compounds with –CH, -CN, -CS, -COOH functional groups. These compounds are spatially linked to inorganic phases that are known catalysts for organic synthesis, i.e., magnetite, pyrrhotite. The organic carbon phases show strong isotopic evidence for their Martian origin, i.e. a large positive δD value of features associated with organics in the region of ~+3500 ‰. These results show unambiguously that Mars has an inventory of organic carbon and nitrogen containing molecules that are produced via electrochemical reduction of CO_2. The results of these analysis where key for the detection and characterization of similar phases by the Curiosity rover (*2,3*).

* - The abstract format is too small to include all the co-authors so I have abbreviated them to the Tissint team, but not their superb contribution for sake of space in the author list - Steele A., Benning L.G., McCubbin F. M., Siljeström S., Hauri E. H., Wang J., Kilcoyne A.L.D., Grady M., Verchovsky A., Sabbah H. , Smith C., Freissinet C., Cyril Szopa, Glavin D. P., Burton A. S., Fries M. D., Rodriguez Blanco J.D., Glamoclija M., Rogers K.L., Mikhail S., Zare R.N., Wu, Q., Dworkin J.P., and Bhartia R.

References: 1. A. Steele, et al., *Meteoritics & Planetary Science* (2016), doi:10.1111/maps.12670. 2. J. L. Eigenbrode *et al*., *Science*. 360, 1096–1101 (2018). 3. A. Steele *et al*., *Science Advances*. 4, eaat5118– (2018).